# Rotational Equilibrium

Name:		Section: 2AL	Date performed://	
Lab station:	Partners:			

### A. Conditions for equilibrium

(Q-1) Determine the location of the center of gravity of the meter stick by balancing the meter stick alone.

$$x_{\text{cg}} = (\underline{\hspace{1cm}} \pm \underline{\hspace{1cm}}) \text{ cm}$$

(Q-2) Now balance the meter stick with 3 weights attached. Use three different weights, each between  $100\,\mathrm{gwt}$  and  $500\,\mathrm{gwt}$ .



	position (cm)	weight (gwt)	lever arm (cm)	torque (gwt cm)
1	±	±	±	±
2	±	±	±	±
3	±	±	±	±

Sum of clockwise torques =  $\pm$ 

Sum of counterclockwise torques =  $\pm$ 

Use this space for calculations.

(Q-3) Do the torques balance? Use the discrepancy test and explain your results.

## B. Weighing a rock

(Q-4) Balance the meter stick with two weights and a rock.



	position (cm)	weight (gwt)	lever arm (cm)	torque (gwt cm)
Rock		XXXXXX		XXXXXXX
Weight 1				
Weight 2				

(Q-5) Assume that the torques balance and use this fact to calculate the weight of the rock.

$$W_{\rm calc} = \underline{\hspace{1cm}}$$

(Q-6) Measure the weight of the rock using an electronic balance.

$$W_{\text{meas}} = \underline{\hspace{1cm}}$$

Calculate the percent discrepancy.

% discrepancy = 
$$\frac{|W_{\text{meas}} - W_{\text{calc}}|}{W_{\text{meas}}} \times 100\% =$$
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Up to this point, we have not considered the weight of the meter stick or the upward force acting on the meter stick due to the fulcrum. Why can we get away with this?

#### C. Weighing the meter stick itself

(Q-7,8) Move the fulcrum away from the center of gravity (not by too much or too little — by about 20 cm is good), and balance the system with one weight.



New fulcrum position = \_\_\_\_\_

	position (cm)	weight (gwt)	lever arm (cm)	torque (gwt cm)
Meter stick		XXXXXX		XXXXXXXX
Weight				

(Q-9) Calculate the weight of the meter stick.

$$W_{\rm calc} = \underline{\hspace{1cm}}$$

(Q-10) Measure the weight of the meter stick by itself, as well as the clamp by itself.

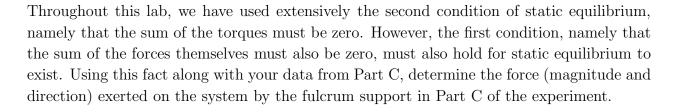
$$W_{\text{meter-stick}} = \underline{\hspace{1cm}} W_{\text{clamp}} = \underline{\hspace{1cm}}$$

Compare the calculated weight in (Q-9) to the measured weight of the meter stick, either with the clamp or without. You must decide if the clamp's weight should be included or not, and back your decision with physical reasoning ("because it's closer" is *not* a valid reason).

$$W_{\text{meas}} = \underline{\hspace{1cm}}$$

% discrepancy = 
$$\frac{|W_{\text{meas}} - W_{\text{calc}}|}{W_{\text{meas}}} \times 100\% =$$
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#### **Exercises**



Did the weight of the clamp figure into your calculations? How is this different from (Q-9) and (Q-10)?